AVENUE

Autonomous Vehicles to Evolve to a New Urban Experience

D2.13 First Definition of AVENUE services

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Lisa Labriga Gonzalo Alcaraz, Anne Mellano	BM	31.07. - 07.08.2018	Review of first services list	AVENUE Services list V1a
Kevin Salvi, Carlos Ballester Lafuente	MT	28.08.- 18.09.2018	Review of list of services according to discussions at common workshop	AVENUE Services list V1b
Lisa Labriga	BM	18.09.- 02.10.2018	Integration of workshop outputs to services list, draft of new services list	AVENUE Services list V2 - draft
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Lisa Labriga	BM	26.10.- 31.10.2018	Inclusion of comments from review, preparation of final version of D 2.13 for submission	D 2.13 “First Definition of AVENUE Services”

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1. Introduction

The target of the AVENUE project is to demonstrate and pilot the adaptability and efficiency of the deployment of small and medium autonomous vehicles (AV's) in Lyon, Luxembourg, Geneva, Copenhagen and 2-3 replicator cities as of the 3d year of the project. The AVENUE vision for future public transport in urban and suburban areas, is that autonomous vehicles will ensure safe, rapid, economic, sustainable[1] and personalized transport of passengers, while minimizing vehicle changes. The goal is to provide door to door autonomous transport allowing commuters to benefit from autonomous vehicles.

At the end of the AVENUE project - 4-year period - the mission is to have demonstrated that autonomous vehicles will be part of the future of public transport. The AVENUE project will demonstrate the economic, environmental and social potential of autonomous vehicles - for both companies and public commuters - while assessing the vehicle road behavior safety.

Work package 2 "Requirements and Use Cases" aims to define in detail the use cases of each demonstrator, the scenarios for each implementation phase, and the value-added services required for the success of the demonstrators. A human-centered design approach for the design of the use cases will be followed. The required data to be collected for the impact analysis will also be defined. Existing knowhow and best practices will be surveyed, assessed and analyzed. The work in the tasks of WP2 is iterative, and as the provided demonstrators and services become more sophisticated, new iterations of the work of the different tasks will be integrated.

Task 2.5 "Demonstrator use case definition" target is to, on the one hand, develop the use case scenarios and, on the other hand, to enrich the provisional list of AVENUE services, selecting at least 10 services for demonstration. Part of the work in task 2.5 feeds into deliverables 2.16-2.18, while the work of T2.5 that feeds into this deliverable focuses on the AVENUE services. The task foresees that these services will be further detailed in line with the needs and feedback from the demonstrator and replicator cities.

This list is the first version of AVENUE services that has been reviewed and approved by all project partners, and in particular the operators of the demonstration sites, as well as the partners responsible for the technical development and implementation of the services (Bestmile, MobileThinking and Navya). It is an accurate picture of the status of discussions and ideas of the operators and other project partners involved right now – logically it will evolve and change over the course of the project.

In this introductory chapter, a complete overview is provided how the First Definition of AVENUE services has been determined. Chapter 1.1 details the methodology and steps taken, while chapter 1.2 describes the evolution of the services that were originally listed in the project proposal.

1.1. Methodology

As below steps show, intense and substantial work has been implemented throughout months 1-5 with the four partners representing the demonstrations sites (Autonomous Mobility – Copenhagen, Keolis – Lyon, Sales-Lentz – Luxembourg, TPG – Geneva), confirmed by Navya, and under guidance

[1] Within urban transportation sustainable most often refers to electric vehicles.

by Bestmile with the help of MobileThinking in order to define the services that are interesting to be developed for phase 1 and those that are relevant to be discussed further for phases 2 and 3:

No	Action	When?	Partners involved	Output
1	Draft of first list of services based on project proposal	July 2018	MT, BM	AVENUE Services list V1
2	Review of first services list	31.07. - 07.08.2018	BM	AVENUE Services list V1a
3a	Workshop with the four demonstration sites – part 2: services	07.08.2018	BM, MT, AM, Keo, SLA, TPG	Meeting notes and workshop documents
3b	Preparation of summary document on workshop	07.08.- 23.08.2018	BM	Summary of workshop with all sites V1
4a	Individual/bilateral follow-up workshop with SLA – part 2: services	08.08.2018	BM, SLA	Meeting notes
4b	Individual/bilateral follow-up workshop with TPG – part 2: services	24.08.2018	BM, TPG	Meeting notes
4c	Individual/bilateral follow-up workshop with AM – part 2: services	27.08.2018	BM, AM	Meeting notes
4d	Individual/bilateral follow-up workshop with Keolis – part 2: services	28.08.2018	BM, Keolis	Meeting notes
5	Preparation of summary document for all workshops (common & individual)	23.08.- 28.08.2018	BM	Summary of all workshops
6	Review of workshops summary document	28.08.- 05.09.2018	AM, Keo, SLA, TPG	*No changes requested*
7	Review of list of services according to discussions at common workshop	28.08.- 18.09.2018	MT	AVENUE Services list V1b
8	Integration of workshop outputs to services list, draft of new services list	18.09.- 04.10.2018	BM	AVENUE Services list V2
9	Review of new services list	04.10.- 12.10.2018	Open to all partners	No changes requested
10	Drafting the first and second version of D 2.13 "First Definition of AVENUE Services"	02.10. - 12.10.2018	BM	D 2.13 "First Definition of AVENUE Services" V1, V2
11	Review of second version of D 2.13	12.10.- 25.10.2018	UNIGE, Navya, AM	Comments on D 2.13 V2
12	Preparation of final version of D 2.13 for submission	24.10.- 30.10.2018	BM	D 2.13 "First Definition of AVENUE Services"

Table 1: Steps taken to arrive to D2.13

Content and structure of the services workshop

First: 3 steps for individual work

1. Suggested services
    a. Interest -> Voting on the services: Would you be interested in this service for your site? → place the colored sticker in your fields (green = yes; yellow = maybe/under certain conditions; red = no)
    b. Comments/Suggestions → add your comments/suggestions to the services, help to explain your voting
    c. Clarification → On some services we had open questions on how to tackle them/ what to address with them. 4 sites where asked to reply to the questions for clarification

2. Additional services: the 4 sites where asked to propose additional services to the ones suggested already
3. Problems to be addressed by services? The DOW mentions several services that are not clear in their description but that all address specific types of problems: a) emergency; b) health; c) security/unsafe feeling of passenger. Sites where asked to provide their input to these services

Then: Presentation of voting, discussion on the problems & reasoning + wrap-up

1.2. Phases of services development

The services in the AVENUE project will be developed in three phases. The phases have been defined as follows in WP 2 and WP4:

	WP2 *Step 1: Definition of the services*	WP4 *Step 2: Development of the services*
Phase 1	M1 – M6	M6 – M18
Phase 2	M13 – M18	M19 – M29
Phase 3	M31 – M36	M30 – M40

Table 2: Phases 1-3 of service definition and development

As the table above shows, the phases defined for WP2 and WP4 are not well aligned. If the phases are kept as such, phase 3 (development) won't be able to start before around M34, after the definition of the phases for phase 3 has been started. In addition, the time left for development and testing of the services in phase 3 is very short then. Therefore, MobileThinking (WP4 leader) and Bestmile (T2.5 leader, WP5 leader) have suggested to adapt the timing of phases 2 and 3 in WP4:

- Phase 2: M20 - M30 (11 months)
- Phase 3: M37 - M48 (12 months)

This suggestion as well as the planning for phases 2 and 3 will be further discussed within the Project Consortium in the next months. If needed, an amendment to the project will be submitted to the European Commission.

1.3. Evolution of AVENUE services during M1-6

The first definition of AVENUE services has been developed under consideration of the inputs from tasks 2.1, 2.2, 2.3, and 2.4, and on the basis of a series of workshops with the four demonstration site operators (AM, Keolis, SLA, TPG) as well as bilateral discussions of Bestmile and MobileThinking. Starting from the list of services included in the project proposal, the list of services has evolved substantially over the past months.

Table 1 lists the services from the project proposal and details their evolution over the past months. In the column "voting" one can see the importance / interest the four demonstration sites expressed for each of the services. Their voting, as well as the complexity of implementation were

the two main selection criteria to determine which services will be developed and tested during phase 1 (M6 – M18).

No	Name	Voting	Evolution
1	Intelligent ticket control	🔴🔴🔴🔴	Discarded
2	Visualization in real time of the path / destination / position of shuttle	🟢🟢🟢🟢	Service phase 1 & ideas for phases 2 & 3
3	In-vehicle entertainment	🟡🟡🟡🟡	Service ideas for phases 2 and 3
4	Virtual personality interaction	🟡🟡🔴🔴	Service ideas for phases 2 and 3
5	Passenger presence	🟢🟢🟢🟢	Service phase 1 & ideas for phases 2 & 3
6	Automatic trip planning suggestion	🟢🟡🟡🟡	Service ideas for phases 2 and 3
7	Intelligent/Integrated trip planner	🟢🟢🟢🟢	Service ideas for phases 2 and 3
8	Trip planned via call centers	🟡🟡🟡🔴	Service ideas for phases 2 and 3
9	On-demand zone notification	🟢🟢🟢🟡	Service ideas for phases 2 and 3
10	Follow my kid / grandmother	🔴🔴🔴🔴	Discarded
11	Mutual help facilitation	🟡🟡🟡🔴	Service ideas for phases 2 and 3
12	On-demand stop	🟢🟢🟢🟢	Service phase 1 & ideas for phases 2 & 3
13	Single button vehicle calls and help request	🟡🟡🟡🔴	Service ideas for phases 2 and 3
14	Emergency automatic call system		→ Problems to address
15	Enhance the sense of security and trust		→ Problems to address
16	Prevention of night aggressions		→ Problems to address
17	Digital or human information points	🔴🔴🔴🔴	Discarded
18	Online ticketing services	🔴🔴🔴🔴	Discarded

Table 3: Lists of services and their evolution over M 1-6

1.4. Structure of the deliverable

This document is structured in four main parts:

- A detailed description of those services that have been selected to be developed and tested during the first phase of the project (chapter 2).
- A list of services that are kept as ideas for phases 2 and 3 of the project (chapter 3). These services need to be further discussed and defined more clearly before potentially being selected in one of the next phases.

- A table overview of those services included in the list of services from the proposal which will not be further considered in the project, as well as the reasons for disregarding them (chapter 4).
- Action points for different project partners for the upcoming phase 1 of the development and testing of services (chapter 5).

Both chapters 2 and 3 already start to include information on hardware needs / recommendations for additional purchases that are needed and/or research to be conducted on services, in order for them to be properly implemented.

2. Services for phase 1

The Phase 1 of service development spans from M6 to M18 (Oct18 – Oct19). For this phase, the following three services have been selected:

1. Visualization in real time of the path/position of shuttle
2. On-demand stop
3. Provide passenger presence information

Each of the services described in this chapter is structured by describing the problem and/or the user story as well as the service versions for phase 1. Some services also detail already ideas for improving the service for the subsequent phases 2 and 3. The tables at the end of each service description detail the different service version ideas, the technical requirements regarding the vehicle / vehicle API, the traveler API, the user application and the operator application. The requirements from one version to the next are cumulative.

Some of the services include an aspect for which right now only the problem or need has been identified, but no solution has been developed yet.

These descriptions intend to provide a clear idea on the service to be developed. The technical development and detailed technical considerations are part of WP4.

2.1. Visualization in real time of the path / position of shuttle

This service is only useful for a fixed-route service. In an on-demand geo-fenced area, the service can't be applied since the matching algorithm might assign the user a vehicle that is not the closest one or even find no match, while the user can see vehicles on the ground and might see a vehicle close to him. Therefore, this gives a wrong perception to the user. In an on-demand system, the user would see the position and path of a shuttle only from the moment when the vehicle has been matched to the user request.

User story

As a user, I want to know the real-time itinerary / position of the shuttles. The user launches the AVENUE application on his smartphone and can easily access and see the position of the autonomous vehicles running in the service area.

Knowing, both before and during the ride, the real-time position of the shuttle increases the usefulness of the system as a whole, and as a consequence, user adoption.

Service versions and technical requirements

Allowing users to see when they will be picked up, where they are during the drive and how long will it take to reach their destination is probably one of the main features that propelled Uber. These are features that could be considered for future versions of this service.

Service version 1 for phase 1	Description	Technical requirements			
		Vehicle / Vehicle API	***Traveler API***	***User app***	***Operator app/PT***
V1	The real-time position of the vehicle is displayed in a map	Send position to AVENUE platform	Provide position of AVs via endpoint	Get real-time position from API and display to end-user	N/A
Idea for future versions of the service	**Description**	**Technical requirements**			
		Vehicle	***API***	***User app***	***Operator app/PT***
V2	Extra information regarding the trip, such as estimated arrival time of the vehicle at pick-up, time to destination, etc. will be provided to the end-user	No change	Provide time remaining for arrival to a particular location via API endpoint	List the extra information obtained from the API along with the previous version information	N/A

Table 4: Service "Visualization in real time of the path/position of shuttle" requirements

2.2. On-demand stop

Problem

As a traveler in the autonomous shuttle, I am annoyed if the bus stops at every bus stop foreseen and nobody wants to get in or out. On the contrary, I want the bus to continue its trajectory, allowing me to reach my destination faster.

User Story

As a user, I want to be able to request a stop from the AV when I need to get off. To increase traffic fluidity, it is envisioned that busses stop only when requested. Therefore, it is required to provide a way for users to request a stop.

The user can request the autonomous bus to stop in certain predefined stops along the path where the bus only stops if requested. By improving the behavior of AV in normal traffic environment, we will increase AV acceptance and therefore adoption.

This service will be redundant once on-demand has been implemented. Therefore, this service as such will only be considered for phase 1 since the project aims at moving towards on-demand systems already during phase 1.

Service versions and technical requirements

Service	Description	Technical requirements

version		*Vehicle / Vehicle API*	*Traveler API*	*User app*	*Operator app/PT*
V1	User can request a stop on demand: - At the bus stop by raising the hand (only possible with an operator / safety driver / groom in each shuttle) - Inside the vehicle by pushing the station stop button	Station stop button functioning	N/A	N/A	Operator to stop the vehicle manually on the requested stop

Table 5: Service "On-demand stop" requirements

Clarification / Development need

All operators are interested to offer the service of requesting a station stop to all users of their services, also those that are not using the smartphone application. Therefore, most of the operators agree that additional possibilities to request a station stop should be developed as additional services, both from inside the vehicle and at a bus stop. The options discussed for this are the following:

- Outside the vehicle:
  - In operation with a safety driver, the safety driver should consider hand signs from passengers at a bus stop. And in an on-demand system?
  - A “request a ride/stop” button/interface of some sort at the bus stop
- Inside the vehicle:
  - Traveler sees where he is going on a screen and chooses his exit/stop based on the route displayed by pushing a station stop button before arriving to that bus stop (like on a classical fixed-route bus line)

To be further discussed/considered:

- What happens if the traveler has chosen destination A but changes his mind during the trip, and would now want to get off at destination B? Consider this question for “manual” on-demand and real on-demand.

2.3. Provide passenger presence information

Problem

There is no means for the end user to know if there is still space for him/her in the autonomous vehicle that s/he is planning to take.

Vehicles are limited in terms of capacity. Which means that it is fairly possible that whenever the AV arrives, it is already full. Therefore, it would be very frustrating for a user to wait for it and not to be able to use it.

User Story

As a user, I'd like to know how full the next AV will be to see if I am still able to fit in the AV (fixed-route) or if I better already start walking to avoid losing time. In an on-demand service, this is a necessary requirement for the matching of demands and dispatching of vehicles. Capacity evaluation needs to be able regardless of my use case (single person, several persons, person in a wheelchair, person with a pram, etc.).

This service is extremely important as it will be the base of many other services like "Real on-demand AV", "Booking system" or "Intelligent trip planner".

Service versions and technical requirements

Service version	**Description**	**Technical requirements**			
		Vehicle / Vehicle API	***Traveler API***	***User app***	***Operator app/PT***
V1	The operator inside the vehicle will count the amount of people in the shuttle and will input it into the system via a companion app. The user will then be able to know the capacity remaining in the shuttle	N/A	Bestmile platform is already capable of receiving this information via the HERMES protocol. In addition, Bestmile platform must be capable of receiving the passenger presence information from the operator companion app and make it accessible via an API endpoint.	The app will display to the user how many people are inside the shuttle and how many free places are remaining	The operator needs to have a companion app that enables the input of the number of persons inside the bus
Ideas for future versions of the service	**Description**	**Technical requirements**			
		Vehicle	***API***	***User app***	***Operator app/PT***
V2	The vehicle will count the number of people inside itself by automatic means such as image recognition or presence sensors	Needs to integrate automatic means of counting people such as cameras for image detection and/or presence sensors (on doors, on seats…)	No change	No change	N/A

V3	The vehicle will, additionally to counting people, count and factor into the remaining free space items such as prams, wheelchairs and or luggage	Image detection algorithms should be able to detect certain type of items	No change	No change	N/A

Table 6: Service "Provide passenger presence information" requirements

Clarification / Development need

All operators confirm that this is a very interesting information – for most it is a required KPI that they need to report to their authorities. Therefore, an automation of the collection of this data is of high(est) interest for all four operators. In Luxembourg, a passenger counting system is even obligatory for all new vehicles. Below further detailed feedback on the service for consideration in the future.

AM: Counting passengers has a high importance for AM. Several aspects:

- Counting for safety purposes (is the bus overloaded) - highest priority
- Counting to allow for booking in on-demand service - necessary requirement
    - Information on the need for a traveler could/should be feature in the user profile of the traveler app ("I am in a wheelchair" or "I usually come with a pram")
- Counting as a business need (how many passengers transported) - 2nd priority
- Counting of the type of space available (wheelchair, pram, big/small person/kid) – last priority

Preferred way of counting?

- TPG:
    - For operations: Don't count the spots available but use a system that calculates the space available for individuals and luggage/prams/wheelchairs.
    - For business/reporting: Traveler counting needed (per person)
    - Recommendation: buy a camera & set up system to test this as a service. This camera could also help to detect if a passenger is sick.
- SLA: Operator app
- Keolis: Sensors, camera, or else
- AM: Foresees a limitation in implementing this, since it might require re-approval by the authorities

In addition to this, the passenger counting system should also evaluate possibilities on how to measure the space availability and reduced passenger capacity when passengers are traveling with a wheelchair, a dog, a pram, heavy luggage, etc.

Recommendation for testing

- The research institutes involved in the AVENUE project are asked to get involved in testing existing systems for automatic calculation of the passengers on board of the shuttle. This could be door sensors or via a camera (as proposed by TPG), but also other existing solutions should be considered. Research and testing on such systems are necessary steps to evolve this service into a fully automated service during phase 2 or 3.

3. Service ideas for phase 2 and 3

This chapter summarizes the feedback on ideas for services for phase 2 and 3, in addition to the version ideas for the three services described above. The chapter is split in three sections: First the services that are of most interest for the operators are discussed, including additional service ideas from the operators, secondly a number of problems are described for which the operators expressed that a service solution would be interesting to them, and lastly the services that are not of most importance or not very interesting to the operators are detailed.

No	Name	Voting	Section
3	In-vehicle entertainment	🟡🟡🟡🟡	5.3 Further services
4	Virtual personality interaction	🟡🟡🔴🔴	5.3 Further services
6	Automatic trip planning suggestion	🟢🟡🟡🟡	5.1 Service ideas for phases 2 and 3
7	Intelligent/Integrated trip planner	🟢🟢🟢🟢	5.1 Service ideas for phases 2 and 3
8	Trip planned via call centers	🟡🟡🟡🔴	5.3 Further services
9	On-demand zone notification	🟢🟢🟢🟡	5.1 Service ideas for phases 2 and 3
11	Mutual help facilitation	🟡🟡🟡🔴	5.3 Further services
13	Single button vehicle calls and help request	🟡🟡🟡🔴	5.3 Further services
14	Emergency automatic call system		5.2 Problems to address
15	Enhance the sense of security and trust		5.2 Problems to address
16	Prevention of night aggressions		5.2 Problems to address

Table 7: Service ideas for phases 2 and 3

3.1. Services of highest interest for the operators

This table lists the services from the project proposal and details their evolution over the past months.

3.1.1. Intelligent / Integrated trip planner

This service is of high interest to the four operators and will thus be considered first after the three services that have been selected for phase 1. The basis for this service is the integration with the scheduling tools / trip planners of the four operators. Integration with the existing public transport systems is foreseen in WP4, starting in M6. If quick progress is made in the integration, it will be considered to start developing this service already during phase 1.

Problem

Users need a reliable way to seamlessly use the autonomous vehicles together with the traditional public transport vehicle network. For the new AV service to be well adopted it needs to be perfectly integrated with the current PTOs' systems.

User Story

As a user, I want to be able to use the new AV service seamlessly in my usual everyday travels. I expect to be able to access information on connections between the AV and other transportation means in the system in real-time, via the application.

By combining the real-time information of the autonomous vehicles collected by Bestmile API with the real-time schedules/routing coming from the public transport company (i.e. TPG) users can know when they should take the autonomous bus to reach their connection to the regular public transport vehicle on time.

3.1.2. On demand zone awareness / notification

Problem

The autonomous shuttle services foreseen in the four demonstration sites will always be limited to a certain service area. When a traveler uses public transportation in a city, s/he will not be aware of these kinds of zones by default. When entering a zone where the possibility of ordering an AV shuttle on-demand exists, the user will thus not now about this possibility.

User Story

As a user, I want to know when I enter an on-demand zone where I can order autonomous vehicles.

How

The idea is therefore to build a service that makes the user aware that he/she is now in an area where the on-demand shuttles can be ordered. This could be done via either the mobile application on the users' phone, which would send a notification when the user enters the geographical zone where the service is offered, or with physical signs at key entry points to the service area.

Clarification need

Data protection issues?

3.1.3. Automatic trip planning suggestions

User Story

As a user, I want to be able to receive automatic trip planning suggestions based on my habits. For example, when I should leave home to reach work on time. The trip planner should consider AVs as well as normal public transport network.

How

By gathering the user's information and habits, we could suggest a departure time for example. As Google is doing, sending a push notification when the users should leave home/work would not only help them, but also remind them of the AV service.

Feedback from the operators

This service is interesting if it exists for the whole city network, not only for the AV shuttle. This however would mean an integration of the service to the general existing apps which is not foreseen. The usefulness of having such a service just for the AV shuttle and only in the specific app remains to be discussed further. What could be interesting however is to alert the user of connections with other means of transportation when planning or having a trip with the AV.

3.1.4. Field Agent App

User Story

As an operator, I want my safety driver to be able to enter and track operational details in an automated way and go away from tracking and monitoring in paper format. As an operator, I also want to be able to monitor the inputs from the safety driver in the Operator Dashboard which I am already using to monitor the vehicle.

How

Bestmile's Field Agent App already provides the possibility to track operational incidents as "field logs" and to display and edit them in the Operator Dashboard. Additional functionalities of the Field Agent App that would be interesting for the operators to be developed are:

- Morning checklist
- Evening checklist
- Signing of checklists
- Attach a picture to an incident report
- Passenger counting

Feedback from the operators

This service has been added to the list of services as a result of the discussion during the different workshops and per strong request from all operators. It would be an important operational tool for the operators that would allow for significant time savings both for the safety drivers as for the supervisor.

3.1.5. Additional services

The operators have identified a number of additional problems / services that would be interesting:

3.1.5.1. Wi-Fi in the bus

While this was mentioned as an interesting additional service from the operators, there is a concern regarding cybersecurity and how a free Wi-Fi connection could potentially negatively

influence network connectivity of the vehicle for driving and the control system. However, not the same network has to be used. In any case this service needs to be carefully evaluated and discussed further throughout the next phase.

3.1.5.2. Detection of vandalism

The intention of this service is to detect vandalism, so that it can be repaired or cleaned overnight and the shuttle looks impeccable again in the morning. The intention of this service is not to identify the origin of the vandalism.

- By camera? -> Comparing pictures of before and after (How does the vehicle look in undamaged shape? Do the seats etc. still look as they should or is there a change? If there is a change, a supervisor could be alerted and the repair initiated).
- By survey? -> Automatically ask travelers after each trip to report vandalism, if any.

3.1.5.3. Inclusive transport service

The key priority to most of the four operators is to provide a) a reliable transport service that is b) for everyone (inclusive). The operators expressed that they will / would like to ideally integrate from the start of their services a service / feature to request the shuttle without using an app. Considering the basic user stories for the use of an AV in an on-demand service, this raises a number of questions:

- How to provide the same services for travelers that don't use an app?
- How to help blind and handicapped people to use the service?
- Is it possible to provide para-transport services?
    - Allow for transportation of handicapped people
    - Need to specify the user needs for a trip (wheelchair, extra help/assistance needed, pram, details on pick-up, drop-down, etc.)
    - Link to passenger presence information?
- Idea for Geneva: At 4-5 stops metal platforms will be installed that allow also for wheelchair users to access the shuttle. These platforms could have a kind of pole with 5 different buttons (= destinations) to request the vehicle. Then an intercom at the stop could announce when the shuttle arrives ("Your shuttle arrives in 5min") and ask the user to press the button again to confirm the request. In addition, some of the hospitals have a reception which could use an interface to request rides for patients, employees, and visitors. An open question remains which solution could be applied for stops that neither have a platform, and nor are at a reception.

3.1.5.4. Using the intercom/loudspeaker system for information messages

All operators expressed an interest to integrate with the built-in intercom/loudspeaker system of the shuttles, to be able to make announcements through the intercom to the travelers, or to be able to play automated messages. Ideas/needs:

- Welcome message on board "welcome on board, please take a seat and attach your seatbelt" → to automatize also the fact that new travelers need to be asked to wear the seatbelt for liability reasons. This message should thus be triggered with every entry of a user to the shuttle.
    - This service would require a sensor at the door that is connected with the intercom/loudspeaker system and which triggers the message once a user enters or before the vehicle starts.
- Usage messages
- Safety messages
- Announcing the next stop

Recommendation for testing

- The research institutes involved in the AVENUE project are asked to get involved in testing a connection of sensors at the door that notice an entry of a user with the loudspeaker system of the shuttle.

3.1.5.5. Using the intercom system to get in touch with an operator

Be able to reach a supervisor/operator through the intercom system and by pressing an emergency button: in an emergency situation or just to request help.

3.1.5.6. Using the road-facing screens for information display

Using the road-facing screens "girouettes" dynamically to display where the shuttle is going, what the next stop is, etc.

3.1.5.7. Services to replace the operator

At the moment, the operator takes over several functions that would need to be replaced by an automated service once the operator is removed from the shuttle. Most initial points concern the communication with the passengers:

- Communicating to potential passengers outside the shuttle on various issues: E.g. signing that passengers have to approach the next stop, before the bus stops.
- Communication to other people in traffic outside the bus: E.g. sign to pedestrians that they have to pass the pedestrian crossing, so that the bus can move past a priority zone.

- Telling inside passengers to comply with safety recommendations: Stay seated until the bus stops completely, that the bus breaks hard, that they have to sit down at all times, etc.
- Answering questions on the actual operation: Where are you driving? Are you stopping at this destination? Is it free to drive?
- Answering questions on the specific pilot project: Who is doing the project? How long will it run? Who is paying for the bus?
- Answering questions regarding the bus and AV's in general: Will it ever go faster? How much does it cost? What are your thoughts on the Uber accident? And various other technical questions.
- Answering "societal" questions: Will bus drivers be unemployed? When will we see this in everyday life and not just as a pilot project? Etc.

Furthermore, the operators help mobility-impaired people to enter or leave the bus and sometimes hold the doors of the bus open for people entering or leaving the bus.

This is a first non-exhaustive list that will be extended over time.

3.1.5.8. Sensors that check if the seatbelts are fastened

In most countries involved it is currently obligatory to have the seatbelts fastened in an autonomous shuttle. Currently, the safety driver alert users of this obligation and ask each new passenger to put on their seatbelt. The idea of this service would be to replace this manual alert that requires a safety driver on board by a sensor that detects if the seatbelts are fastened and, if not, triggers a message to be played via the loudspeakers that asks the passengers to fasten their seatbelts.

3.2. Problems to be addressed

In the project proposal, a few services have been proposed that were not convincing in their description as a service but that address potential problems. For these problems, the PTOs have been asked to identify which of these they would like to address with a specific service, and how that service should look like. The outcomes of this work are summarized in this chapter and evolve around three problems identified:

- Emergency situations (accident, technical breakdown, etc.)
- Health problem (sick passenger etc.)
- Situations in which a passenger doesn't feel safe and might need some special attention (women travelling alone at night, but also elderly people that are maybe insecure about the AV)

3.2.1. Emergency situations

All four operators would like to see this problem addressed with a service. Currently, the operator/ safety driver reacts to an incident by informing the emergency services and the passengers.

Once the operator gets removed from the shuttle, ideas to fulfill these needs are as follows:

- Information of passengers: Via intercom/loudspeaker system, allowing the operator to address the people in the shuttle
- Reaction & information of emergency services: Operator that monitors all shuttles gets alerted from the shuttle or supervises via the cameras.

3.2.2. Health problems

All operators would like to see this problem addressed with a service. Ideas to do so:

- Emergency call / Help button inside the vehicle
- Connection to operator via intercom allows to call the supervisor in case of a health issue
- Interior camera that can detect when a person falls down / is sick
- Monitoring through the safety driver on board or the operator via the cameras[2]

3.2.3. Unsafe feeling

All operators would like to see this problem addressed with a service. Ideas to do so:

- Emergency / Help button that triggers interference of operator (on-site supervisor)
- Emergency / Help button in the traveler app
- On-site supervisor regularly checks the vehicle and monitors the cameras
- Fire needs to trigger an emergency automatic opening of the door

3.3. Further services

3.3.1. In-vehicle entertainment

User story

As a user, I want to be entertained while being transported in the autonomous vehicles.

How

Displaying visual feedback on what the shuttle sees / technical information / advertisements etc., either on the app or on the shuttles' screens.

Feedback from the operators

- A screen inside the vehicle that displays operational details about the shuttle and its track (arrival times, connections, maybe also cultural information about the city) would be very interesting and a priority

[2] Note : It needs to be ensured that all systems that rely on camera surveillance or other tools fulfil the GDPR regulation as well as local laws.

- Additional entertainment options are of less priority to the operators, such as sightseeing features

3.3.2. Virtual personality interaction

User Story

As a user, I want to be able to receive information and interact with the different services offered in the vehicle using natural language and with a well-known personality I can trust, which represents the autonomous vehicle services.

How

Via a Chatbot in the mobile application.

Feedback from the operators

Mixed to low interest. A system like Watson or a virtual personality interaction could be an interesting feature as of day 1 but it is not essential to the service proposition and therefore of lower priority.

3.3.3. Trip planned via call centers

User Story

As a user, I want to be able to plan a trip even without using IT devices.

How

To face this problem APTs could have a call-center dedicated to help non-autonomous and not tech-savvy people to plan/book their trip. This call-center could be human at first and automated when possible.

Feedback from the operators

All operators agree that they want to provide an inclusive service that is open to everyone, also to non-smartphone users. This implies, that some sort of additional way of booking a ride needs to be offered – doing so via a call center would be one option. Lots of practical questions remain for implementation (see also workshop summary document).

3.3.4. Mutual help facilitation

Problem

For non-fully autonomous people or elderly people, using an AV is not necessarily an easy task. On top of that, asking a stranger for help can be difficult for some people.

User Story

As a user, I would like to know how to help fellow passengers. As a user, I would like to tell other passengers or the autonomous service that I need help.

How

In the dedicated mobile application, there could be a section that would help to connect people. For example, if a person with reduced mobility needs help to exit the bus, she could ask for it by pressing a button (in the bus or in the application itself). Then people in the bus would get notified and engaged into providing help.

Feedback from the operators

As long as there is a safety driver / operator in the shuttle, this will be less of a problem or need. Once the safety driver is removed, some sort of help facilitation could indeed proof to be very useful. Often people help each other naturally – if this is not the case the on-site supervisor could intervene and announce through the intercom system that someone needs help.

3.3.5. Single button vehicle calls and help request

Problem

Calling for an AV using a smartphone could be problematic for people that do not have or are not familiar with smartphones.

User Story

As a user, I want to call a bus in front of my house or signal a request for help with a button tap.

Feedback from the operators

Most operators are generally interested in such a service since it allows for providing an inclusive service to everyone, which is a priority to the operators. Many questions remain regarding the practicalities of setting up such a service:

- How and where to set such buttons up?
    - Makes sense in specific sites such as hospital area where it could be set up at a reception
- How can the traveler confirm the ride?
    - It needs to be more than a single button, maybe a little Kiosk or a tablet instead?
    - If it is a single button, like for a lift, then the time of arrival of the shuttle is displayed and then the traveler needs to confirm. If the traveler doesn't confirm, the request will be cancelled.
- How to know the destination of the traveler?
    - Seems to be feasible only for fixed-route on-call use case, and therefore would have to be implemented early in the project.

Misuse could be avoided by setting up cameras at the bus stop.

4. Discarded services

This list contains the list of services that have been discarded by the consortium during the first six months of the project and work on the services. The following table lists the name of these services, the user story behind as well as the reasons to discard the service.

No	Name	User story	Reason to discard
1	Intelligent ticket control	As a user, I want a seamless ticketing system.	Ticketing system is PTO dependent and therefore shouldn't be addressed in the scope of the AVENUE project. Also, the PTOs already have their solution, it therefore doesn't make sense to develop something in parallel.
10	Follow my kid / grandmother	As a user, I would like to see that my relative/friend is safe.	Security is ensured by wider global means put in place by PTOs and local authorities and the service falls out of the scope of the project. PTOs have furthermore no interest in this service.
17	Digital or human information points	As a user, I want to be able to get information about the service in other places than on the web/via an app.	PTOs have no interest in this service.
18	Online ticketing services / Convoy service	As a user, I would like to book trip for me / As a user, I would like to book a group trip involving several autonomous vehicles.	Ticketing system is PTO dependent and therefore shouldn't be addressed in the scope of the AVENUE project. Also, the PTOs already have their solution, it therefore doesn't make sense to develop something in parallel.

Table 8: Discarded services